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Reducing the Risk of Hypercholesterolemia through Aerobic Exercise and Consumption of Lovastatin in "*Angkak*" to Get the Financial Profit

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Abstract

The current high prevalence of degenerative diseases is due to a diet that tends to be high in cholesterol, protein, and salt but lacking in fiber st can cwhichse various conditions, including dyslipidemia. Hypercholesterolemia is part of dyslipidemia, namely disturbances in fat blood levels as a manifestation of metabolic disorders or cholesterol transport that can lead to a high risk of heart disease. This study aims to determine the effect of Angkak on aerobic exercise on LDL and triglyceride levels. Methods: A double blind comparison clinical trial with a before and after treatment design, was carried out in Palembang City from August to September 2021. A total of 33 women in the aerobic exercise group who met the inclusion and exclusion criteria were taken randomly, and divided into two groups, namely 17 the sample of the treatment group was given aerobic exercise with 2.4 grams of Angkak steeping, and 16 samples of the comparison group were given only aerobic exercise. The data obtained were analyzed using a t-test. The study results showed differences in LDL and triglyceride levels before and after aerobic exercise by giving Angkak. There is an effect of giving Angkak in aerobic exercise on LDL and triglyceride levels, which indicate hypercholesterolemia in women.

Keywords
Angkak; aerobic exercise; cholesterol; LDL; triglycerides

I. Introduction

Advances in technology and industry have indirectly increased people's income; the impact is that people's purchasing power increases, especially in food consumption. People's diet will eventually shift from a traditional diet to a diet that tends to be high in cholesterol, protein, and salt but lacking in fiber (Azirak & Engineering, 2005). This can cause the high prevalence of degenerative diseases lately, one of which is dyslipidemia. Hypercholesterolemia is a disorder of fat levels in the blood (dyslipidemia) with cholesterol levels in the blood of more than 240 mg/dl (Perkeni, 2004), as a manifestation of metabolic disorders or cholesterol transport disorders (Putri & Larasati, 2020; WRESDIYATI et al., 2006); Yani, 2015). Hypercholesterolemia is one part of hyperlipidemia (increased blood cholesterol and triglyceride levels). There are two types of hypercholesterolemia in terms of causes: primary hypercholesterolemia and secondary hypercholesterolemia. Primary hypercholesterolemia, in addition to being hereditary, can be influenced by age, gender, stress, drinking excessive coffee, smoking a lot, and being alcoholic. On the other hand, secondary hypercholesterolemia is caused by diseases such as diabetes mellitus, obesity, nephrotic syndrome, and hyperthyroidism (Stuart Gail W, 2019).

Exercising is better at controlling blood cholesterol levels than a fat diet. Families who consume foods that are sources of fat but have regular exercise habits have relatively the same blood cholesterol levels as families who consume low-fat foods with little activity (do not have exercise habits) (Drummond & Murphey-Reyes, 2017; Gao et al., 2020; Gordon et al., 2019). Regular physical exercise according to body condition is beneficial in cholesterol regulation, namely reducing total cholesterol, low-density lipoprotein (LDL)-cholesterol, and triglycerides, while high-density lipoprotein (HDL)-cholesterol increases significantly (Gao et al., 2020). Physical exercise can burn many calories so that the body looks slimmer and the body weight becomes ideal (Aires, 2003).

Endurance training will increase the ability of muscles to take up and oxidize free fatty acids during exercise and activate the lipoprotein lipase enzyme (Gao et al., 2020). The power of aerobics to reduce plasma triglycerides has been investigated by Schneider and Kachadurian (1992), concluding that aerobic exercise can reduce plasma triglycerides. Research on 652 patients found that a three-week exercise program reduced total and LDL cholesterol by 20%, triglycerides decreased by 33%, and the ratio between total cholesterol and HDL decreased by 13% (Chavarrias et al., 2019).

Financial performance is a measuring instrument to know the process of implementing the company's financial resources (Ichsan, R. et al. 2021). Financial performance is an illustration to determine the financial condition of a company for a certain period and is analyzed using financial analysis tools (Cashmere in Susiowati., et al, 2020). Financial analysis that can be used is financial ratios such as profitability ratios and activity ratios. (Hery in Susiowati., et al, 2020).

Lovastatin is a cholesterol-lowering drug belonging to the statin class. Lovastatin is a hypocholesterolemic agent that can reduce serum cholesterol levels in the blood. Lovastatin is very effective for treating hypercholesterolemia because it is a competitive inhibitor of 3-hydroxy-3-methylglutaryl-coenzyme-A (HMG-CoA) reductase (Wang et al., 2017). Lowering cholesterol levels is primary and secondary prevention of heart disease and other complications of atherosclerosis. Lovastatin is also known as monacolin K or mevinolin. This compound can be used as a drug to reduce human blood cholesterol levels, because this compound can inhibit cholesterol synthesis by inhibiting the activity of HMG-CoA reductase. This enzyme determines cholesterol biosynthesis (Brown and Goldstein, 1991). Routine administration of lovastatin to patients with hypercholesterolemia can reduce blood cholesterol levels by up to 30% (Triana & Nurhidayat, 2009; Wang et al., 2017).

Angkak is the result of fermented rice with the fungus Monascus purpureus. Common people refer to Angkak as Chinese brown rice because the product is red, made from rice, and historically comes from China (Coritama et al., 2021). With the advancement of science, Angkak is now also used for medical purposes. Angkak contains lovastatin compounds that can be used as drugs (Kasim et al., 2012; kauri.retno, 2008; Sulistyorini et al., 2011). (Pichardo-Almarza et al., 2015), lovastatin can reduce blood cholesterol levels by 11-32% and triglyceride levels by 12-19%. Research presented at the 39th annual congress of the American Heart Association in 1999 showed that giving Angkak for 8 weeks can reduce total cholesterol levels by 16-22.7%, LDL by 21-31%, and triglycerides by 24-34%. Meanwhile, HDL cholesterol increased by 14-20% (kauri.retno, 2008).

A study conducted at UCLA and published in the American Journal of Clinical Nutrition found that giving 2400 milligrams of red yeast rice to rats reduced cholesterol, triglycerides, and LDL after 8 weeks. The researchers did not find any adverse effects on liver and kidney function tests conducted after and before treatment (Kasim, 2006).

II. Research Method

This type of research is a double-blind comparison clinical trial, with a "before and after treatment design". The sample was divided into two groups, namely the treatment group in the form of aerobic exercise with Angkak and the comparison group in the form of aerobic exercise with a placebo, physical activity in the form of aerobic exercise + giving Angkak carried out three times a week for eight weeks. Laboratory examinations in the form of analysis of LDL and triglyceride levels were carried out at BBLK (Health Laboratory Center) Palembang. The study was conducted in August-September 2012. The population was all women members of the PKK, Demang Lebar Daun Village, Palembang. Based on the calculation of the sample obtained, a sample of 34 people. To anticipate the occurrence of dropouts plus 10% so that the total sample is 37 people and those who drop out are four people.

III. Results and Discussion

3.1 Results

a. General Characteristics Respondents based on Age

From table 1. below, it can be seen that the majority of respondents aged 41-45 years amounted to 13 people (39.4%), followed by respondents aged 36-40 years as many as 12 people (36.4%), and respondents aged 30-35 year as many as eight people (24,2%).

Table 1. Frequency Distribution Respondents By Age

Age	N	%
30-35 year	8	24,2
36-40 year	12	36,4
41-45 year	13	39,4
Total	**33**	**100**

The high number of patients who are overweight at the age of over 30 years is caused by the fact that with age, several changes in the body arise, the body's metabolism decreases, and the increase in body fat is associated with a person's lipid profile (Czerwinski et al., 2007, 2007; Sharma et al., 2007). al., 2013). A decrease in daily physical activity exacerbates this. Another reference states that the body fat percentage increases with age, usually starting at 20-30 (Lin et al., 2020; Reis et al., 2020). If left over 40 years old, it becomes a critical age because heart diseases and DM are a threat at this age.

b. Height

From table 2. below, it can be seen that the most respondents, 15 people (45.5%), have a height of 160 cm, followed by ten respondents (30.3%) who have a height of 150-154 cm and eight respondents (24.2 %) has a height of 155-160 cm.

Table 2. Frequency Distribution of Respondents by Height

Height	N	%
150-154 cm	10	30,3
155-159 cm	8	24,2
≥ 160 cm	15	45,5
Total	**33**	**100**

Height is closely related to a person's weight because it can measure body mass index in adults. As an indicator of wasting and stunting in children, it is also associated with a person's body fat, where the results are accurate and easy to do. And can be used to analyze whether the person is overweight.

c. Weight

From table 3. below, it can be seen that the most respondents weight 66 kg were 19 people (57.6%), followed by body weight of 61-65 kg as many as eight people (24.2%) and six people (18.5%). 2%) with a body weight of 55-60 kg.

Tabel 3. Frequency Distribution of Respondents by Weight

Weight	N	%
55-60 kg	6	18,2
61-65 kg	8	24,2
≥ 66 kg	19	57,6
Total	**33**	**100**

People who are overweight or obese store fat in the abdomen, the rest in the thighs and hips. Obese people tend to have high levels of triglycerides that are stored under the skin, this is the main ingredient in the formation of very low density lipoprotein (VLDL)-cholesterol and LDL-cholesterol in the liver, which will enter the blood, so weight is more likely to be the cause of increased cholesterol levels. total (Abd El-Kader et al., 2016; Ciccone et al., 2010; Xiong et al., 2021).

d. Based on Body Mass Index

From table 4. below, it can be seen that the highest BMI for overweight was 14 people (42.4%), followed by BMI with average weight as many as 13 people (39.4%) and six people (18, 2%) BMI with mild excess weight.

Table 4. Frequency Distribution of Respondents Based on Body Mass Index

Body Mass index	N	%
Normal Weight	13	39,4
Light weight excess	6	18,2
Excess weight weight	14	42,2
Total	**33**	**100**

The higher the BMI or a person's weight, the more at risk of high total cholesterol levels (Heslet, 2002). WHO has defined several BMI ranges that reflect the risk of certain diseases. In some population groups, such as South Asians, health risks may increase at lower BMI values (Kaß et al., 2021; Yogman & Eppel, 2019). Excessive nutritional status occurs when the body obtains nutrients in excessive amounts, causing toxic or harmful effects (Lugovaya & Averyanova, 2021; Reichel et al., 2009; Tomori et al., 2020).

Tabel 5. Comparison of LDL and levels triglycerides before aerobic exercise with and without giving raises in the treatment group and the comparison group

Var	Treatment Group	Treatment Group	*p***
	Before		
	Average ±SD	Average ±SD	
LDL Mg/dl	133,71 ± 36,81	119,19 ± 31,78	0,782
Trigliserida Mg/dl	155,25 ± 45,27	160,14 ± 22,99	0,486

** **t- unpaired Test**

From table 5, it can be seen that the results of the unpaired t-test showed p = 0.782 (LDL) and p = 0.486 (triglycerides) before aerobic exercise with and without giving Angkak to both groups, meaning that there was no significant difference between the treatment group and the comparison group. Normality test can be concluded that the data is normally distributed.

e. Giving Effect Rating in Gysmany Aerobics on Levels LDL and Triglyceride

Tabel 6. Comparison of LDL and levels aerobic exercise triglycerides with and without giving in the treatment group and comparison group

Var	**Treatment Group**		***P****	**Comparison Group**		***P****	***P****
	Avarage±SD			**Avarage±SD**			
	Pre	**Post**		**Pre**	**Post**		
LDL Mg/dl	133,71 ± 36,81	97,77 ± 27,76	0,000	119,19 ± 31,78	106,33 ± 37,40	0,026	0,001
TG Mg/dl	155,25 ± 45,27	123,51 ± 40,66	0,000	160,14 ± 22,99	143,83 ± 19,91	0,000	0,000

*** : t- in pairs Test** **** : t- unpaired Test**

From table 6 above in the treatment group, the mean LDL level was 133.71 mg/dl ± 36.81 and the mean triglyceride level was 155.25 mg/dl ± 45.27 before aerobic exercise with Angkak, while the mean LDL level was 97,7 mg/dl ± 27.76 and the mean triglyceride level was 123.51 mg/dl ± 40.66 after aerobic exercise with Angkak. The results of statistical tests obtained p = 0.000 (LDL) and p = 0.000 (triglycerides), so it can be concluded that there is a significant difference between before aerobic exercise and giving Angkak and after aerobic exercise by giving Angkak.

Table 6 also shows that in the comparison group, the mean LDL level was 119.19 mg/dl ± 31.78, and the mean triglyceride level was 160.14 mg/dl ± 22.99 before aerobic exercise,e while the mean LDL level was 106.33 mg/dl. ± 37.40 and the mean triglyceride level was 143.83 mg/dl ± 19.91 after aerobic exercise. The statistical test results obtained p = 0.026 (LDL) and p = 0.000 (triglycerides), it can be concluded that there is a significant difference between before aerobic exercise with after aerobic exercise.

The results of the unpaired t-statistic test in the treatment group against the comparison group obtained p-value = 0.001 (LDL) and p-value = 0.000 (triglycerides), meaning that there was an effect of giving Angkak in aerobic exercise on LDL and triglyceride levels.

3.2 Discussion

In the treatment group, there was a decrease in LDL levels by 35.95 mg/dl and triglycerides by 31.74 mg/dl also, in the comparison group, there was a decrease in LDL levels by 12.74 mg/dl and triglycerides by 16.31 mg/dl, although a reduction of relatively smaller than the treatment group but there is an effect of aerobic exercise on LDL and triglyceride levels in the comparison group, this is due to the increased activity of the lipoprotein lipase (LPLA) enzyme in fat and muscle tissue during aerobic exercise, the activity of this enzyme is positively related to HDL levels and triglycerides. Aerobic exercise can increase LPLA enzyme activity, and increased LPLA can reduce VLDL and chylomicron levels and strengthen the clearance of VLDL, which is rich in cholesterol and chylomicron remnants; LPLA is involved in the triglyceride degradation process and provides material for the manufacture of HDL which is known to be an active metabolite of several hours after exercise, triglycerides, and VLDL are converted to cholesteryl esters in LDL and HDL mediated by cholesteryl ester transfer protein which then triglycerides in HDL and LDL are hydrolyzed by lipase enzymes which ultimately lead to a reduction in the size of HDL and triglyceride particles. , 2008; Khoerunnisa et al., 2018).

The intensity of exercise also affects reducing LDL where regular physical exercise according to body conditions in cholesterol regulation can reduce LDL and triglyceride levels; the greater the intensity of the exercise, the greater the possibility of decreasing LDL and triglyceride levels, so that the risk of coronary heart disease will be reduced. Amjadian, 2020; Fink, 2016; Maiti & Bidinger, 2014).

In the treatment group, there was a decrease in LDL and triglyceride levels, apart from aerobic exercise activities, but also the effect of steeping Angkak. This is due to Monascus Purpureus, which produces lovastatin/monacolin, a compound that can lower blood cholesterol levels in the body. The monacolin compounds will inhibit the action of the enzyme 3-hydroxy-3-methylglutaryl CoA reductase (HMG-CoA reductase), an enzyme needed for cholesterol synthesis. HMG-CoA reductase inhibitors can reduce intracellular cholesterol stores and inhibit the synthesis of very low density lipoprotein (VLDL) in the liver. VLDL is a precursor of LDL; inhibition of VLDL synthesis will automatically reduce the amount of LDL and triglycerides (Subrandate; indira setyorini, Dwi; Yunike; Kusumawaty, Ira; Fatimah, Mustika; Sabrina, Tia; Maritska, Ziske; Febri Zulissetiana, Eka; Pratiwi, Ratih ; Legiran; Parisa, 2022).

In line with the opinion of William Adi Teja in Hanafi, 2004 who concluded that Angkak strengthens the body, whatever the dose, Angkak will improve blood circulation and pump the heart better. Other evidence The American Heart Association did research on the use of red red onion in 1999. The first research involved 187 people with high cholesterol, LDL 130 mg/dl and cholesterol 230 mg/dl the results were shown to reduce

total cholesterol by 16%, and LDL cholesterol by 21%, while HDL values increased to 24%.

This is in line with research which states that lovastatin contained in Angkak can reduce blood cholesterol levels by 11-32% and triglyceride levels by 12-19%. This is because Monascus purpureus in Angkak contains several active ingredients, the dominant being monacolin/lovastatin which inhibits HMG-CoA reductase in cholesterol synthesis (Kasim et al., 2012). Research presented at the 39th American Heart Association congress that giving Angkak for 8 weeks can reduce total cholesterol levels by 16-22.7%, LDL by 21-31%, and triglycerides by 24-34% while increasing HDL by 14-20. %. Some literature says Angkak can be used in the treatment of hypercholesterolemia and hyperlipidemia. Sesuai juga dengan penelitian pada serum hewan coba dan manusia, diketahui bahwa *Monacolin K* (*lovastatin* atau *mevalonin*) pada angkak dapat menurunkan kadar lipid dengan cara menghambat aktivitas *HMG-CoA reductase* dalam sintesis kolesterol pada hati(Dehnavi et al., 2020; Yarmolinsky et al., 2020). Angkak juga mengandung serat, magnesium, asam lemak tak jenuh (seperti *niacin*) yang bermanfaat dalam mengurangi kadar kolesterol total, menurunkan kadar LDL, meningkatkan kadar HDL serta menurunkan kadar trigliserida pada serum (Sulistyorini et al., 2011; Triana & Nurhidayat, 2009). Selain itu, kandungan sterol (*beta sitosterol* dan *campesterol*) pada angkak mampu menghambat absorbsi kolesterol pada usus halus(Azirak & Engineering, 2005).

Several studies have concluded that Angkak can reduce levels of total cholesterol, LDL cholesterol, and triglycerides. High cholesterol levels are undesirable because they can increase the risk of cardiovascular diseases, such as atherosclerosis, heart disease, stroke, and hypertension. With the inhibition of the HMG-CoA reductase enzyme by compounds present in Angkak, the rate of cholesterol synthesis in the body is inhibited, so that it can significantly reduce body cholesterol levels (Kasim et al., 2012; kawuri.retno, 2008; Triana & Nurhidayat, 2009).).

Angkak which is a traditional food can be an alternative for women to avoid the risk of hypercholesterolemia or increased blood cholesterol levels. This finding can be the basis for health workers in promoting health for women with risks such as entering pre-elderly age or women who are overweight (Nursanti & Kusumawaty, 2021; Retnosari & Kusumawaty, 2021). Puskesmas is an alternative in maintaining the health of the elderly, especially mothers.

IV. Conclusion

A total of 33 women in the aerobic exercise group who met the inclusion and exclusion criteria were taken randomly, and divided into two groups, namely 17 the sample of the treatment group was given aerobic exercise with 2.4 grams of Angkak steeping, and 16 samples of the comparison group were given only aerobic exercise. The study results showed differences in LDL and triglyceride levels before and after aerobic exercise by giving Angkak. There is an effect of giving Angkak in aerobic exercise on LDL and triglyceride levels, which indicate hypercholesterolemia in women.

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